Diagnostic and Therapeutic Endoscopy, Vol. 7, pp. 7–14
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Angioscopic Observation after Coronary Angioplasty for Chronic Coronary Occlusion Comparison with Severe Stenotic Lesion

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(Received 27 April 2000; Revised 12 June 2000; In final form 12 June 2000)

Objectives **To clarify the underlying mechanism for the high restenosis rate after the coronary angioplasty for the chronic total occlusion by using the coronary angioscope.**

Background **Coronary angioplasty for the chronic total occlusion is associated with higher restenosis rate than for highly stenotic lesion. However, the difference in the restenosis rate has not been discussed from the angioscopic observation.**

Methods and Results **The lesion morphology after coronary intervention were classified into 4 grade (Grade 0 = no intimal flap; Grade 1 = intimal flap without protrusion; Grade 2 = Intimal flap with protrusion not occlusive; Grade 3 = protruding intimal flaps with occlusion of the vessel lumen). Coronary angioscopic observation was performed in 46 patients with stable angina. Most of the lesion morphology after angioplasty in 13 patients with chronic total occlusion was grade 3. On the other hand, none of grade 3 was observed in 36 patients with severe coronary stenosis.**

Conclusion **The various protrusions into the lumen shown by the angioscope might be a reason for higher restenosis and reocclusion rates compared with those after the angioplasty for the severe stenotic lesion.**

Keywords: Angioplasty, Chronic total occlusion, Coronary angioscope, Stent

INTRODUCTION

Percutaneous transluminal coronary angioplasty has become a standard treatment for the patients with coronary heart disease. With the substantial advances in devices and improvements in operators' skill, coronary angioplasty has been applied to the various type of coronary morphology, so called complex lesions. One of the complex lesions is the chronic total occlusion. Since the first study

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cohort was reported in 1982 [1], many studies dealing with chronic total occlusions has been reported [2]. The beneficial effects of successful angioplasty for the chronic total occlusion has been reported: Anginal state often improves after successful angioplasty; left ventricular functions may improve [3–5]; and subsequent referral for coronary bypass graft surgery is uncommon [6–8]. In spite of these beneficial effects, two major problems are existed. One is the initial success rate, which has reached over 70% in recent reports [2,9]. Selection of the lesions for more favorable outcome and newer devices may improve the initial success rate [10]. Another problem is the very high restenosis rate following the successful recanalization. A restenosis rate of 44 to 77% limits the long-term benefit of angioplasty [11], however the reason for this high restenosis rate has not been elucidated.

Coronary angioscope is a tool for the intracoronary imaging and would be useful to observe characteristics of the lesions before and after coronary interventions to evaluate the effects of the interventions. Our coronary angioscopic catheter is 0.75 mm in outer diameter with a fiber containing 6000 pixels, which has power to observe clearly the neointimal coverage of the stent [12,13] or the lesion characteristics in patients with acute coronary syndrome received reperfusion therapy [14].

We observes the chronically total lesions with angioscope after successful angioplasty may help to understand the high restenosis rate. In this point of view, we angioscopically studied the lesion morphology with chronic total occlusion after successful intervention and compared with that of after successful the high grade stenoses and discussed the mechanism for the high rate of restenosis for the chronic total occlusion.

METHODS

Patients Selection

Of patients with stable angina treated angioplasty from January to December 1996, 49 patients were enrolled in this study; Thirteen patients with successful angioplasty for chronic total occlusion (CTO group) and 36 patients with successful angioplasty for severe stenosis lesion (non-CTO group). None of the patients within one month after acute myocardial infarction and with poor left ventricular function were enrolled in this study. If the angioscopic images obtained after intervention, patients were excluded. This study protocol was approved by the Osaka Police Hospital Ethical Committee.

Angioscopic Procedures and Evaluations

After obtaining the written informed consent, coronary angiography and intervention were performed according to standard procedure by the femoral approach. Angiographic success of the dilatation was achieved when the stenosis diameter after the balloon was $< 50\%$. If the angiographic appearance of the target lesion was suboptimal by coronary angiograms, further large size balloon was used until the satisfactory results were obtained. After the completion of successful dilatation, angioscopic observation were made. We used the angioscope MC-800E (Nihon Kohden) and the optic fiber AS-003 (Nihon Kohden). The angioscopic observations were made while the blood was cleared away from the view by the injection of 3% dextran-40 as described previously [12]. We examined the culprit lesions treated by intervention and evaluated the lesion morphology. The lesion morphology were classified into 4 grades as shown in Fig. 1; grade 0 is lesion with no flap, grade 1 is lesion with the intimal flap without protrusion, grade 2 is lesion with protruding flaps without occlusion of the vessel lumen, and grade 3 is lesion with protruding flaps occluding the vessel lumen. The presence or absence of yellow plaque and thrombus at culprit lesion after angioplasty was also evaluated by the angioscope. The angioscopic images were reviewed by a specialist who was unaware of the angiographic lesion characteristics and patient's background.

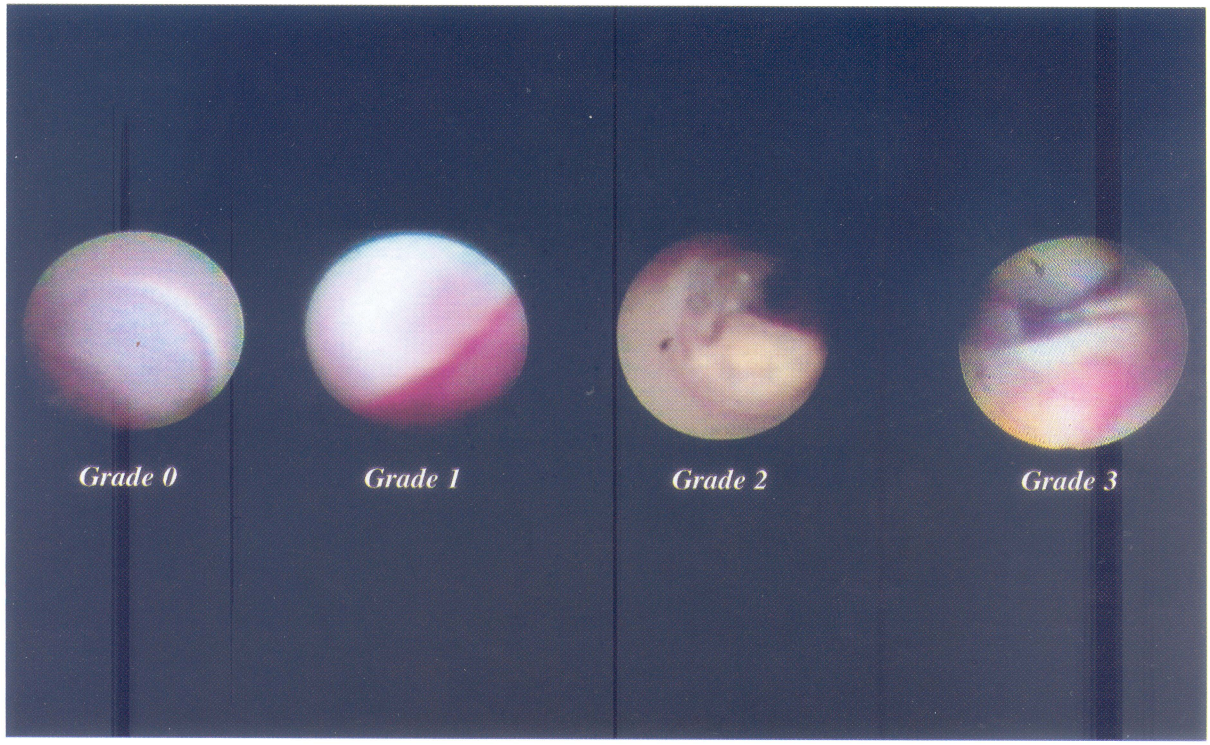

FIGURE 1 Classification of lesion morphology observed by angioscope. Grade 0 = no intimal flap; Grade 1 = intimal flap without protrusion; Grade 2 = intimal flap with protrusion not occlusive; Grade 3 = protruding intimal flaps with occlusion of the vessel lumen.

Statistics

All data were presented as mean ± SD. For the analysis of the difference between two groups, the two-tailed Student *t* test was used in case of standard deviation. Categorical data were compared by the chi-square test. A statistical probability of $p < 0.05$ was considered to be significant.

RESULTS

Patients Characteristics

The baseline characteristics were shown in the Table I. There were no differences between CTO and non-CTO group in terms of age, gender and target vessel distribution. The incidence of previous myocardial infarction was significant higher in CTO group than in non-CTO group.

Angioscopic Observation

Fig. 2 shows the representative angioscopic findings of non-CTO group. Yellow plaque was observed at the lesion and intimal flap with protrusion was also observed and its lesion morphology was classified into grade 2. Fig. 3 showed the representative angioscopic findings of CTO group. The yellow plaque with thrombus was observed at the lesion and tremendous amounts of intimal flap occluding the lumen with wire was observed. The lesion morphology was grade 3. The distribution of lesion morphology were shown in Fig. 4. After intervention, grade 3 was 62% in CTO group, however grade 3 was observed in only 1

TABLE I Base line characteristics between CTO group and non-CTO group

	CTO group	Non-CTO group	*p* value
Age (yrs)	55 ± 9	60 ± 11	ns
Sex (male/female)	11/2	30/6	ns
Previuos MI (%)	84.6%	52.8%	ns
Target artery (LAD/LCx/RCA)	9/0/4	21/3/12	ns

MI: myocardial infarction, LAD: left ascending artery, LCx: Left circumfex artery, RCA: right coronary artery.

patient (3%). On the other hand, grade 0 was 24% in the non-CTO group, nevertheless grade 0 was observed in none of patients with CTO group. Thus, the significant distribution differences in lesion morphology between CTO and non-CTO group ($p < 0.05$). The yellow plaque was observed in all patients with CTO group and 83.3% in non-CTO group, but the difference was not significant. Thrombus was observed more frequently in non-CTO group (47.2%) rather than CTO group (30.8%), but the difference was not significant (Fig. 5).

DISCUSSION

Coronary angioscope revealed a terrible intra-coronary observation after the revascularization

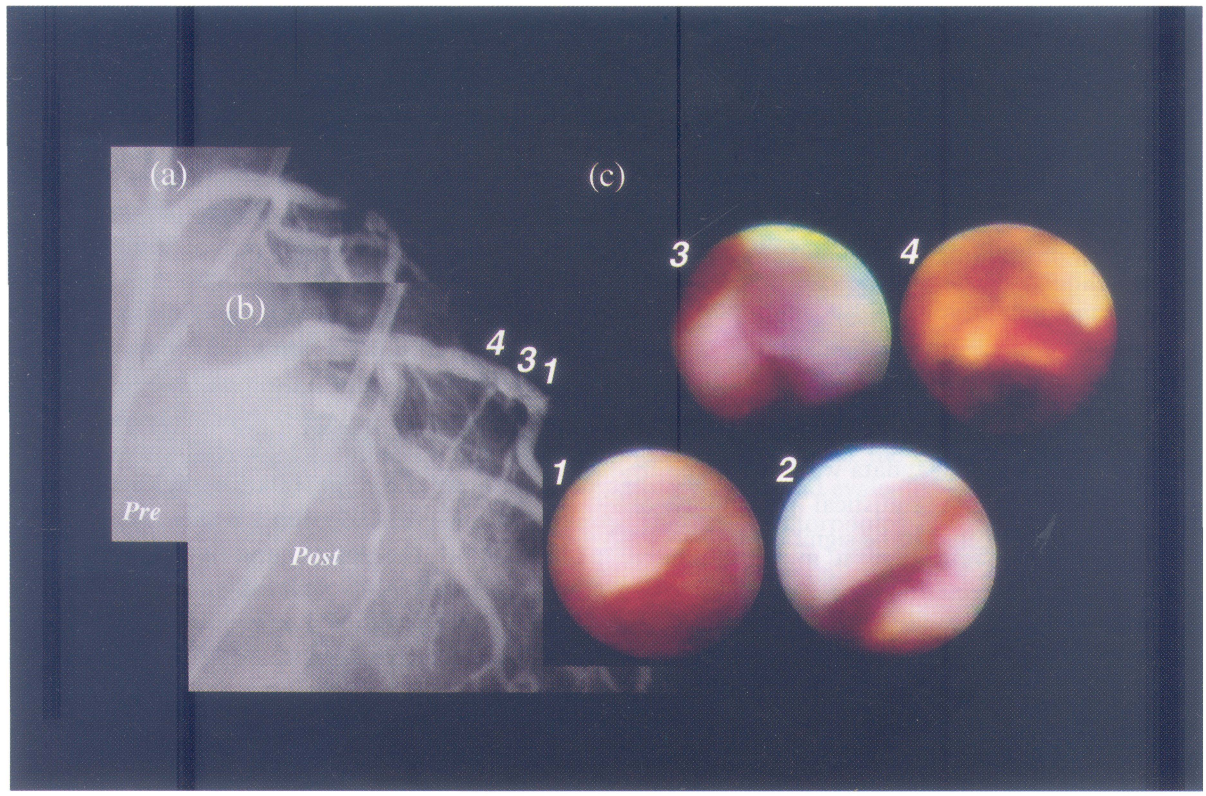

FIGURE 2 Representative angioscopic images after angioplasty for severe stenotic lesion (non-CTO group). Coronary angiograms pre (a), post intervention (b) and the angioscopic images after intervention (c) were shown. The number of each angioscopic image corresponds to that of the location shown in the coronary angiogram. Yellow plaque was observed at the culprit lesion and non-occlusive intimal flaps were observed.

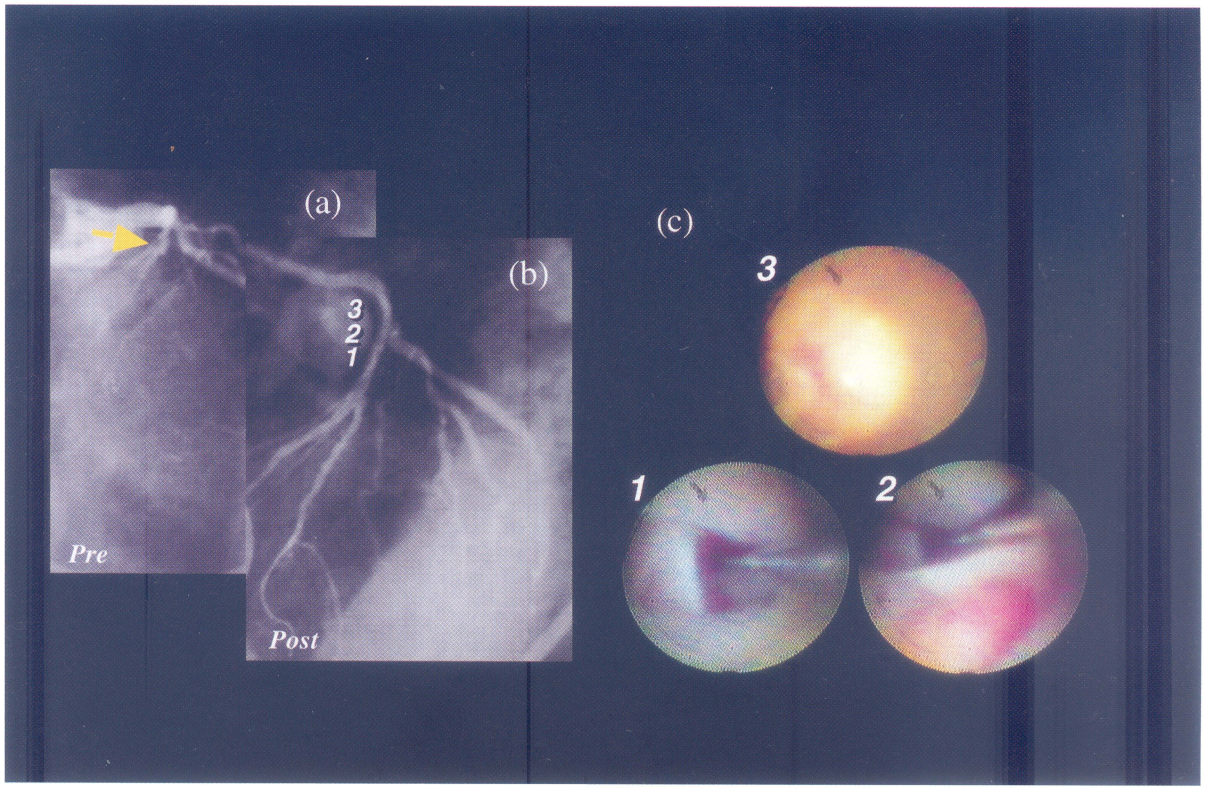

FIGURE 3 Representative angioscopic images after angioplasty for chronic total occlusion (CTO group). Coronary angiograms pre (a), post intervention (b) and the angioscopic images after intervention (c) were shown. The number of each angioscopic image corresponds to that of the location shown in the coronary angiogram. Yellow plaque and white thrombus was observed at the culprit lesion and occlusive protrusions were observed around the guide wire.

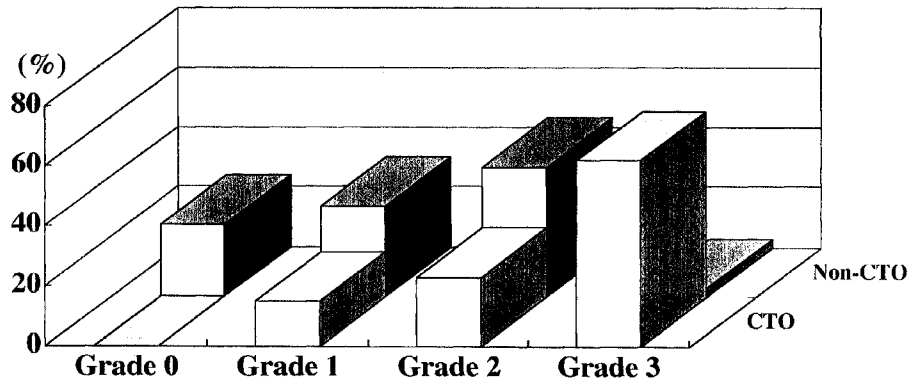

FIGURE 4 Distribution of the lesion morphology evaluated by angioscope after angioplasty between CTO and non-CTO group.

of the chronic total occlusion, that is, large intimal flaps or the thrombus with various lesions at the culprit site protrude from the vessel wall and occupy the vessel lumen, even if angiography showed the enough vessel lumen after the balloon angioplasty as described before [15]. On the other hand,

angioscope after the successful angioplasty for the severe stenotic lesion showed also flaps, but the amounts and the degree of protrusions were less than after chronic total occlusion. These protruding lesions might disturb the coronary flow and causes the thrombus formation. Thrombus once formed at the intervention lesion contribute the restenosis by itself as well as enhance the neointimal hyperplasia [16], the other cause of restenosis [17]. Thus, the various protrusions into the lumen shown by the angioscope might be a reason for higher restenosis and reocclusion rates compared with those after the angioplasty for the severe stenotic lesion.

Recently, coronary artery stenting has emerged as a valuable therapeutic strategy for the management of chronic total occlusion [18–20]. Intracoronary insertion of the Palmaz-Shatz stent or Wiktor stent after successful angioplasty of chronic total occlusion has been associated with favorable restenosis and reocclusion rate, improved short- and long-term outcome [21, 22]. Our angioscopic observation showed the suppression of the occlusive protruding intimal flaps or thrombus and keep the lumen open as shown in Fig. 6. The preventive mechanism for the restenosis of stent is explained by the prevention of chronic vessel shrinkage [23], However, these compressions of protruding materials to the vessel wall might be the another mechanism for the prevention in the case of chronic total occlusion.

All patients with chronic total occlusion in our study suffered from myocardial infarction previously. As it is well known that acute myocardial infarction caused by the occlusive thrombus formation following plaque rupture, the total lesion suspected to have rich thrombus. The angioscopic observation showed that fewer incidence of thrombus in the CTO group compared with non-CTO group. Total occlusion comprises athrosclerotic plaque and a single or multiple layers of clot formed by repeat injury repair process [2]. Angioscope can recognize fresh clots as a thrombus, however as the older and more fibrosed clot were present in the lesion with total occlusion, angioscope cannot detect the thrombus.

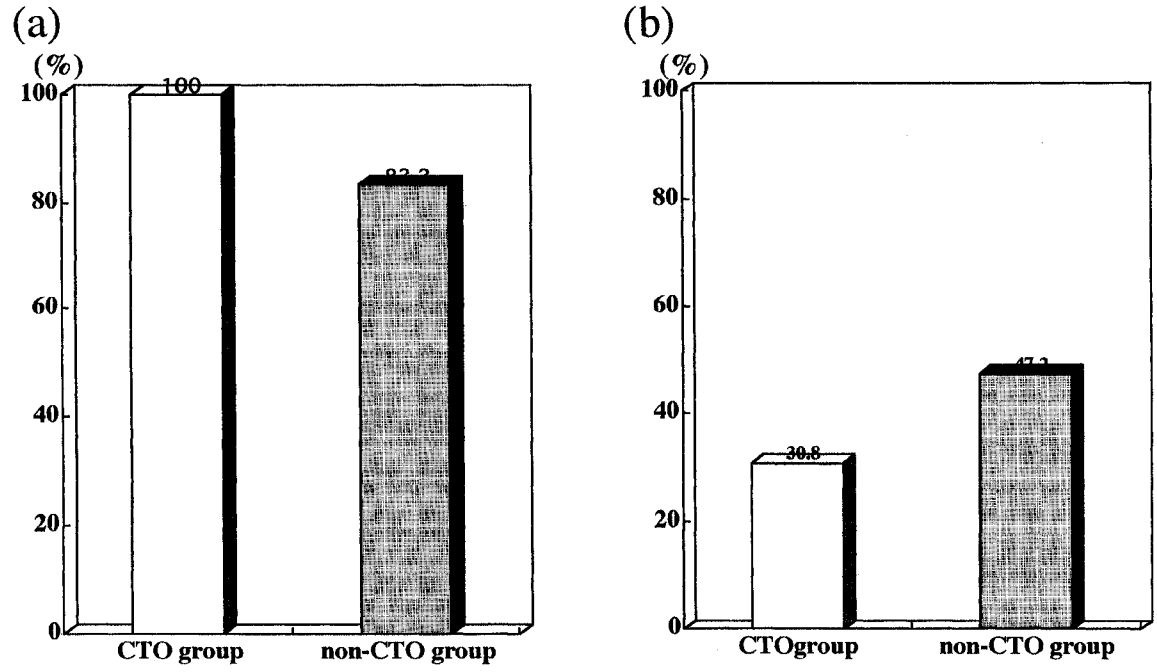

FIGURE 5 Incidence of yellow plaques (a) and thrombus (b) at the culprit lesion in CTO and non-CTO group.

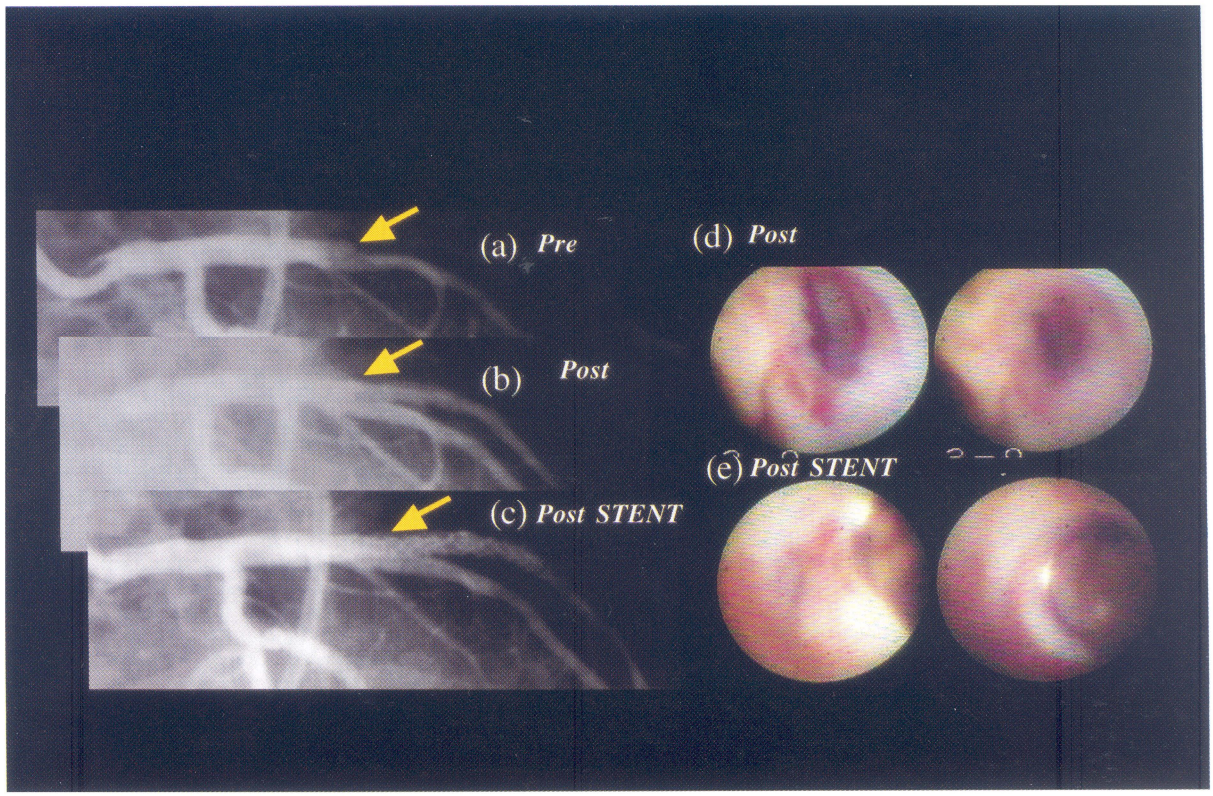

FIGURE 6 The compression of occlusive protrusions after angioplasty after chronic total occlusion by stent. Coronary angiograms pre (a), post (b) and after stenting (c) were shown. Angioscopic images after angioplasty and stenting were shown in (d) and (e), respectively.

Furthermore, histologic findings depicted that there were loose fibrous tissue was dispersed in the total occlusion site [24], which means less thrombus. The culprit lesions with high stenotic grade showed yellow plaque in 80% of patients and thrombus formation in half of them. The incidence of the yellow plaques a little bit higher than the previous reports indicating that yellow plaques were detected in the target vessel of angioplasty in about 60% of patients with stable effort angina [25]. It may be explained that the high incidence of yellow plaque in this study patients with severe stenotic lesions were selected among the patients with stable effort angina subjected to angioplasty. This also may explain the high incidence of thrombus observed by angioscope in patients with non-CTO group.

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